

ADDITIONAL REPORT ON FRESHWATER PLANARIANS FROM NORTH BORNEO, MALAYA, SRI LANKA, INDIA, AND SOUTH AFRICA

by

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I. INTRODUCTION

After the publication of a series of taxonomic papers by the senior author on freshwater planarians from several countries of Asia (The Philippines, Borneo, Indonesia, Malaya, Thailand, India, Pakistan, and Afghanistan) and South Africa, a number of triclad materials from these areas were sent to the senior author for identification. The purpose of this paper is to present the records of these species of paludicolen triclads occurring in several localities such as North Borneo, Malaya, Sri Lanka (Ceylon), India, and South Africa. All the species studied here belong to planariid genus *Dugesia*.

The North Bornean material was collected by the junior author who has been studying the distributional ecology of freshwater planarians in South-west Japan as one of the co-researchers of the senior author.

II. SPECIES DESCRIPTIONS

Order TRICLADIDA

Suborder PALUDICOLA or PROBURSALIA

Family PLANARIIDAE

Genus *Dugesia* GIRARD, 1850

Dugesia borneana KAWAKATSU, 1972

Figs. 1 (A-E) and 2

Dugesia borneana KAWAKATSU, 1972. Contr. Biol. Lab. Kyoto Univ., 23 (3-4): 115-122+Pl. 1.
Original description.

Material and Locality: KAWAKATSU's Specimen Lot No. 1159 group. A mountain stream at Head Quarter, the Kinabaru National Park (the mountain side of Mt. Kinabaru), Sabah, North Borneo. Altitude, about 1600 m. December 28, 1972. Eleven specimens fixed in Bouin's fluid, 15 to 18 mm long and 2.5 mm broad, were examined. Only one specimen was observed in a sexually mature state. Water temperature, 16°C. Coll. G. ÔGAWARA.

This is a typical mountain stream (about 60 cm in width and 5-6 cm in depth) running through a jungle of Mt. Kinabaru. The water was very clean (cf. ÔGAWARA 1972, 1973, In press).

External Characters: The appearance of the preserved specimens is shown in Figure 1 (A and B). The largest living specimen may reach about 17 to 20 mm in body length and 3 mm in width. The head has a broad subtriangular form with rather wide, bluntly pointed auricles.

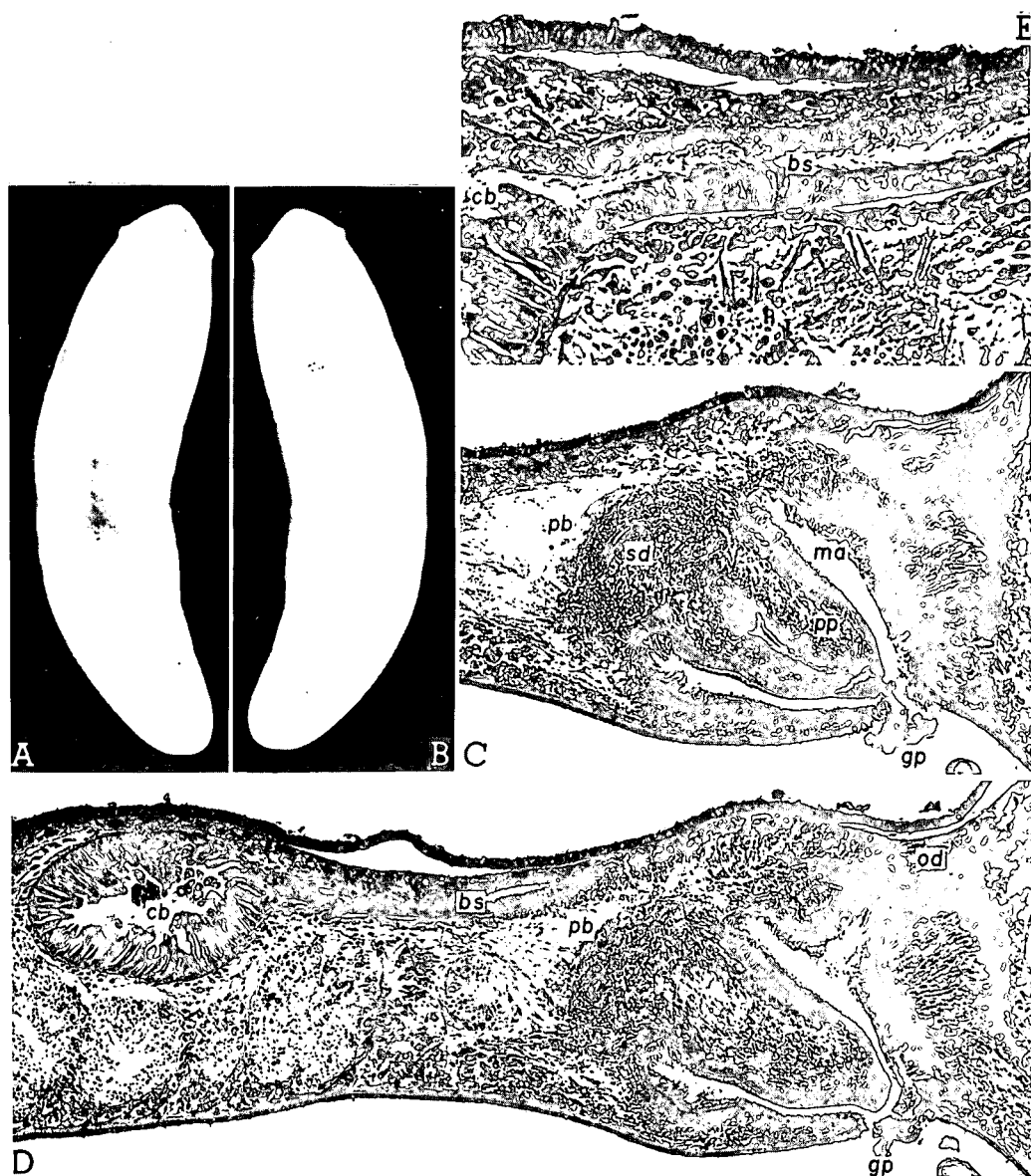


Fig. 1. *Dugesia borneana* from North Borneo (Specimen Lot No. 1159 group). A: a preserved sexually mature specimen (No. 1159 h). B: ventral view of the Specimen A. C and D: photomicrographs of the mid-sagittal (B) and near mid-sagittal (C) sections of the copulatory apparatus (No. 1159 h). E: enlarged photomicrograph of the anterior part of the bursa stalk (No. 1159 h).
bs: bursa stalk; **cb**: copulatory bursa; **gp**: genital pore; **ma**: male antrum; **od**: ovovitelline duct; **pb**: penis bulb; **pp**: penis papilla; **sd**: sperm duct.

The color of the dorsal side is uniformly grayish brown with numerous, very small and dark pigments. An indistinct, dark colored, mid-dorsal line can be seen. The ventral side is of a light brown color.

The two eyes, each surrounded by a usual clear space, are situated on the dorsal side of the head; the distance between them is about one-third of the head at the level of the eyes. A pair of the

non-pigmented auricular sense organs is conspicuous. In the preserved specimens indistinct white stipples or sensory spots (10 in number) could be seen at the anterior margin of the head.

The pharynx is inserted at about the middle of the body and measures in length almost one-sixth to one-seventh the length of the body. The genital pore is at about the middle of the post-pharyngeal region.

Internal Characters: The anterior intestinal trunk bears about 15 branches on each side. Each posterior trunk has 15 to 20 or more short lateral branches. The external muscle layers of the pharynx consist of outer longitudinal and inner circular fibres. The pharynx is infected by numerous specimens of an endoparasitic Nematode species.

The distinctive genital anatomy of *Dugesia borneana* has been described in a previous paper (KAWAKATSU 1972 b). Numerous dorsal testes, ovaries and yolk glands were observed in the slides examined (No. 1159 h). Photomicrographs of the parts of the copulatory apparatus of the Mt. Kinabaru specimen are shown in Figure 1 (C-E). Figure 2 shows the sagittal view of the copulatory apparatus of that specimen.

Anatomically the copulatory apparatus of *Dugesia borneana* has no conspicuous local variation between the Mt. Kana specimen (holotype) and the Mt. Kinabaru specimen. In the Mt. Kinabaru specimen, however, a very small diaphragm separates the bulbar cavity from the ejaculatory duct (Figs. 1 C, 2). Although this character is not conspicuous in the slides of the holotype (see KAWAKATSU 1972 b, p. 118, Fig. 2, Pl. 1, Fig. A), a typical form of *Dugesia borneana* may have this structure in its penis lumen. On this point, a part of the original definition of the species should be changed. The main characters of the copulatory apparatus are as follows: penis bulb large, hemispherical in shape and strongly muscular with a moderately wide pestle-shaped bulbar cavity into which sperm ducts enter separately; slightly asymmetrical penis papilla large and cylindrical form with small diaphragm in the ejaculatory duct which is slightly ventrally located in the papilla; without a valve surrounding the papilla at the basal part; copulatory bursa moderate to large, with a narrow and extraordinarily long bursal canal which opens into the common genital antrum; the posterior half of the bursa stalk forms a well-developed vagina into which ovovitelline ducts enter separately.

Slides: Nine sets of serial sections (Specimen No. 1159 a-i) and whole mounts are preserved in KAWAKATSU's laboratory of Fuji Women's College, Sapporo.

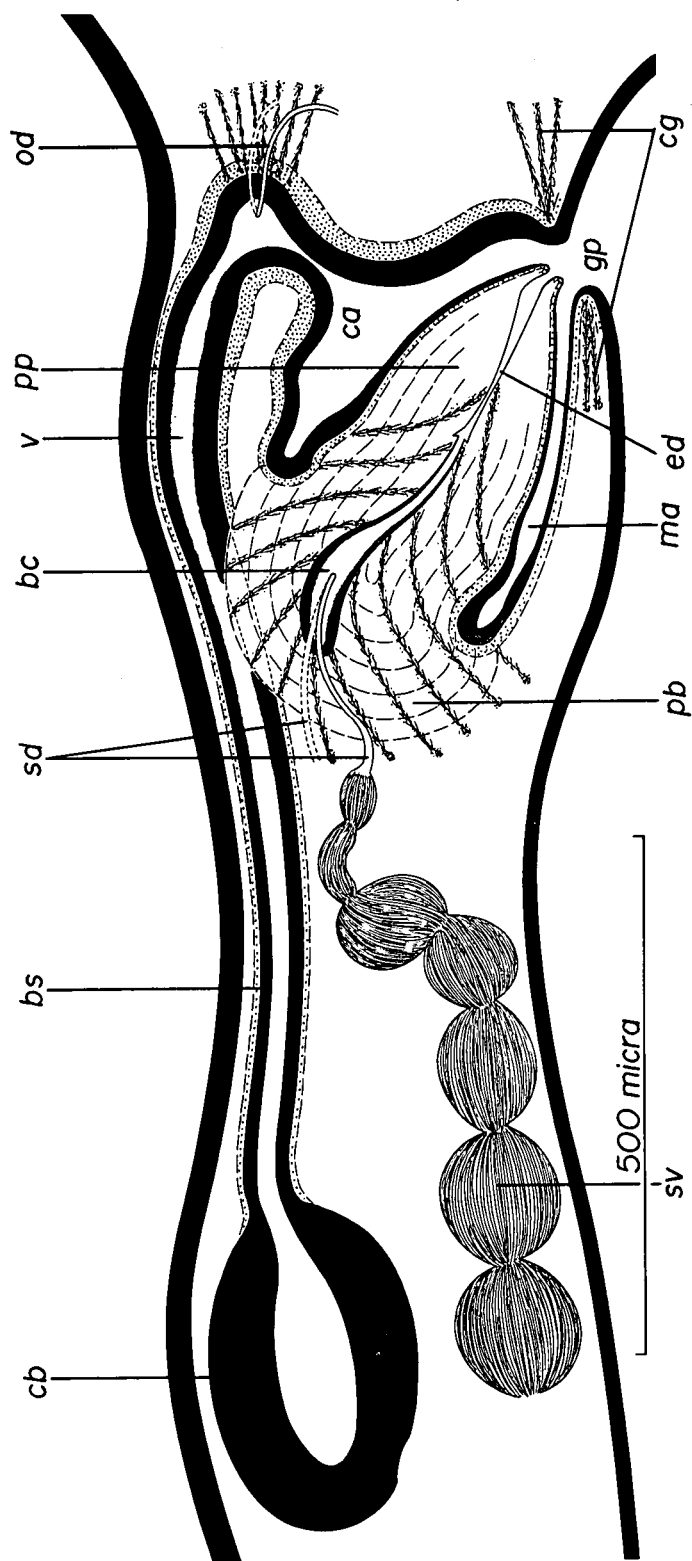
Remarks: From the study of the penial anatomy of the additional specimen, it is found out that *Dugesia borneana* has a small diaphragm in the penis lumen. The species is clearly a member of the *Dugesia gonocephala* group. On this point the senior author's discussion about the taxonomy of this species (cf. KAWAKATSU 1972 b, pp. 119-121) should partly be corrected.

Among the Asiatic *Dugesia* species, the following five species have a striking resemblance to *Dugesia borneana* in the anatomy of the copulatory apparatus. They are: *Dugesia japonica* ICHIKAWA et KAWAKATSU, 1964, from the Far East including the Japanese Islands; *Dugesia* (olim *Planaria*) *burmaensis* (KABURAKI, 1918) from Inlé Lake in Burma; *Dugesia* (olim *Planaria*) *andamanensis* (KABURAKI, 1925) from the Andaman Islands; *Dugesia nannophallus* BALL, 1970, from Ceylon; *Dugesia indica* KAWAKATSU, 1969, from Middle India. However, all these species have a highly asymmetrical penis papilla. *Dugesia borneana* is easily separable from these Asiatic species in its slightly asymmetrical penis papilla, extraordinarily long bursa stalk and well-developed vagina.

***Dugesia* sp. (species of Cameron Highlands)**

Fig. 3 (A-C)

Dr. Minoru SUDZUKI of Nihon University kindly sent the senior author the triclad material from Malaya including both freshwater and terrestrial planarians (cf. SUDZUKI 1973).



Material and Locality:
KAWAKATSU's Specimen Lot Nos. 1133 and 1200 groups. A small stream (Sungai Semai) of Cameron Highlands, west-central part of the Malay Peninsula (Malaysia). Altitude, about 1200 m. May 14, 1972 (No. 1144 group, one specimen) and March 26, 1973 (No. 1200 group, two specimens). These three specimens preserved in 3% formalin, 5 to 10 mm long and 0.5 to 1 mm broad, were examined. They were observed in a sexually immature state. Coll. Dr. M. SUDZUKI.

External Characters: The appearance of the preserved specimens is shown in Figure 3 (A-C). The preserved non-sexual specimens attain about 5 to 10 mm in body length and 0.5 to 1 mm in width. The head has a broad subtriangular form with low, bluntly pointed auricles.

The color of the dorsal side is uniformly light brown with numerous, small, blackish brown pigments. The ventral side shows a light coloration.

Fig. 2. Diagram showing the sagittal view of the copulatory apparatus of *Dugesia borneana* (No. 1159 h). bc: bulbar cavity; bs: bursa stalk; cb: copulatory bursa; cg: cement gland; ed: ejaculatory duct; gp: genital pore; ma: male antrum; od: ovovitelline duct; pb: penis bulb; pp: penis papilla; sd: sperm duct; sv: spermiducal vesicle; v: vagina.

The two eyes are situated on the dorsal side; the distance between them is about one-third of the head at the level of the eyes. A pair of non-pigmented ocular areas and of the auricular sense organs are conspicuous.

The pharynx is inserted at about the middle of the body and measures in length almost one-fifth to one-sixth the length of the body. In the histological sections the external muscle layers of the pharynx consist of outer longitudinal and inner circular fibres.

Slides: One set of serial sections (Specimen No. 1144 a) and two whole mounts (Specimen No. 1200 a and b) are preserved in KAWAKATSU's laboratory of Fuji Women's College, Sapporo.

***Dugesia* sp. (species of Penang)**

Figs. 3 (D-G) and 4

Material and Locality: KAWAKATSU's Specimen Lot No. 1145 group. An artificial pond located in the Campus of the University of Sains Malaysia (Universiti Pulau Pinang), Penang, Malaysia. Altitude, about 100 m. Many specimens, probably collected in 1970 and fixed in 70 % ethyl alcohol,

were retained in Dr. RAMACHANDRAN's room. About 40 specimens separated from the material by Dr. SUDZUKI were examined. They were 6 to 7 mm long and 0.5 to 1 mm broad and were observed in a sexually immature state except for only one non-fully mature specimen.

External Characters: This is a small, pigmented species. The appearance of the preserved specimens is shown in Figure 3 (D-G). The preserved specimens attain about 6 to 7 mm in body length and 0.5 to 1 mm width. The head has a broad subtriangular form with short auricles. The "neck" is not conspicuous in the preserved specimens.

The color of the dorsal side is

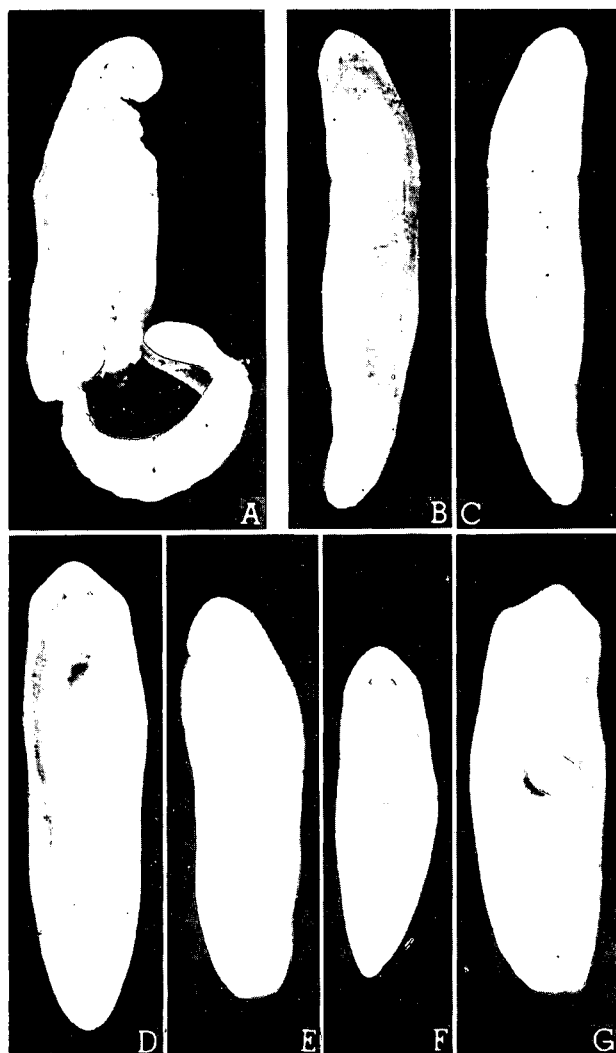


Fig. 3. *Dugesia* sp. (species of Cameron Highlands) (A-C; Specimen Lot Nos. 1144 and 1200 groups) and *Dugesia* sp. (species of Penang) (D-G; Specimen Lot No. 1145 group) from Malaysia. A: a preserved sexually immature specimen (No. 1144 a). B: a preserved sexually immature specimen (No. 1200 a). C: ventral view of the Specimen B. D-G: four preserved sexually immature specimens (No. 1145 group). G: ventral view.

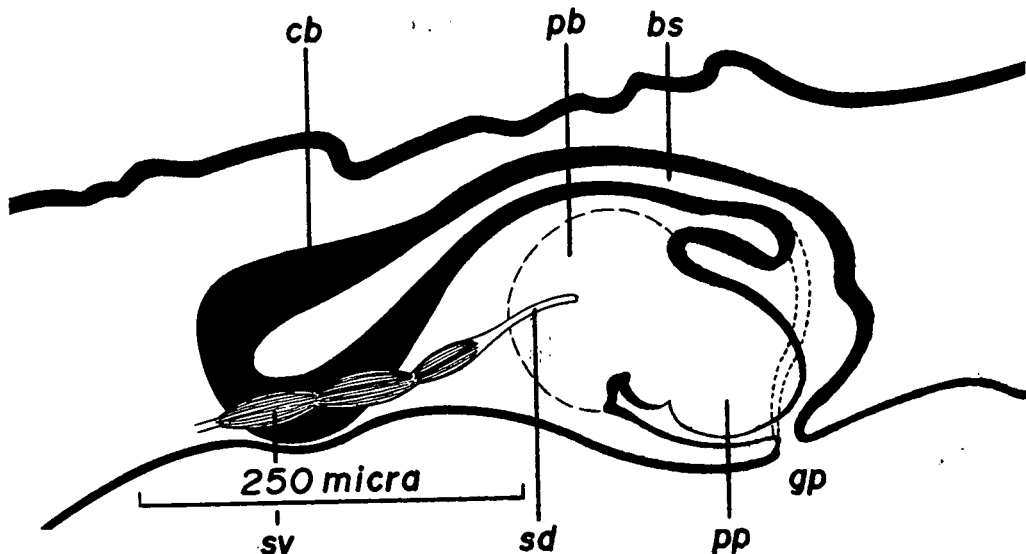


Fig. 4. Diagram showing the sagittal view of the copulatory apparatus of *Dugesia* sp. (species of Penang) (No. 1145 c; non-fully mature specimen). Abbreviations, see Fig. 2.

uniformly light brown. The ventral side is a lighter hue.

There are two large eyes on the dorsal side of the head; the distance between them is about one-third of the head at the level of the eyes. A pair of the auricular sense organs is very small.

The pharynx is inserted at somewhat anterior level of the body and measures in length almost one-fifth the length of the body.

Internal Characters: The external muscle layers of the pharynx consist of outer longitudinal and inner circular fibres.

Only one specimen (No. 1145 c) has a part of the copulatory apparatus (Fig. 4). Testes, ovaries and ovovitelline ducts were not observed. The characters of the copulatory apparatus are as follows: penis bulb large, spherical in shape; penis papilla moderately large and highly asymmetrical; part of the spermiducal vesicles can be seen; copulatory bursa large, with a rather long bursal canal which opens into the genital pore (bursal canal has a nucleate epithelium).

Slides: Eleven sets of serial sections (Specimen No. 1145 a-k) and several whole mounts are preserved in KAWAKATSU's laboratory of Fuji Women's College, Sapporo.

Remarks: Parts of the sections of the Specimen No. 1145 c were lost. Because of the absence of the fully sexually mature specimens, the identification of the species is impossible. However, this species may not be identical with *Dugesia batuensis* BALL, 1970. The latter form was recorded from the Batu Caves (cf. BALL 1970; KAWAKATSU 1972 a) and the vicinity of Kuala Lumpur (cf. KAWAKATSU 1972 c), Malaysia. It is highly probable that *Dugesia* sp. (species of Penang) is identical with *Dugesia* sp. (species of Cameron Highlands) recorded in the foregoing paragraph.

***Dugesia nannophallus* BALL, 1970**

Figs. 5 (A-F) and 6

Dugesia nannophallus BALL, 1970. Zool. Jour. Linnean Soc., 49 (4): 272-278, Figs. 1-3, Pl. 1, Fig. A. Original description.

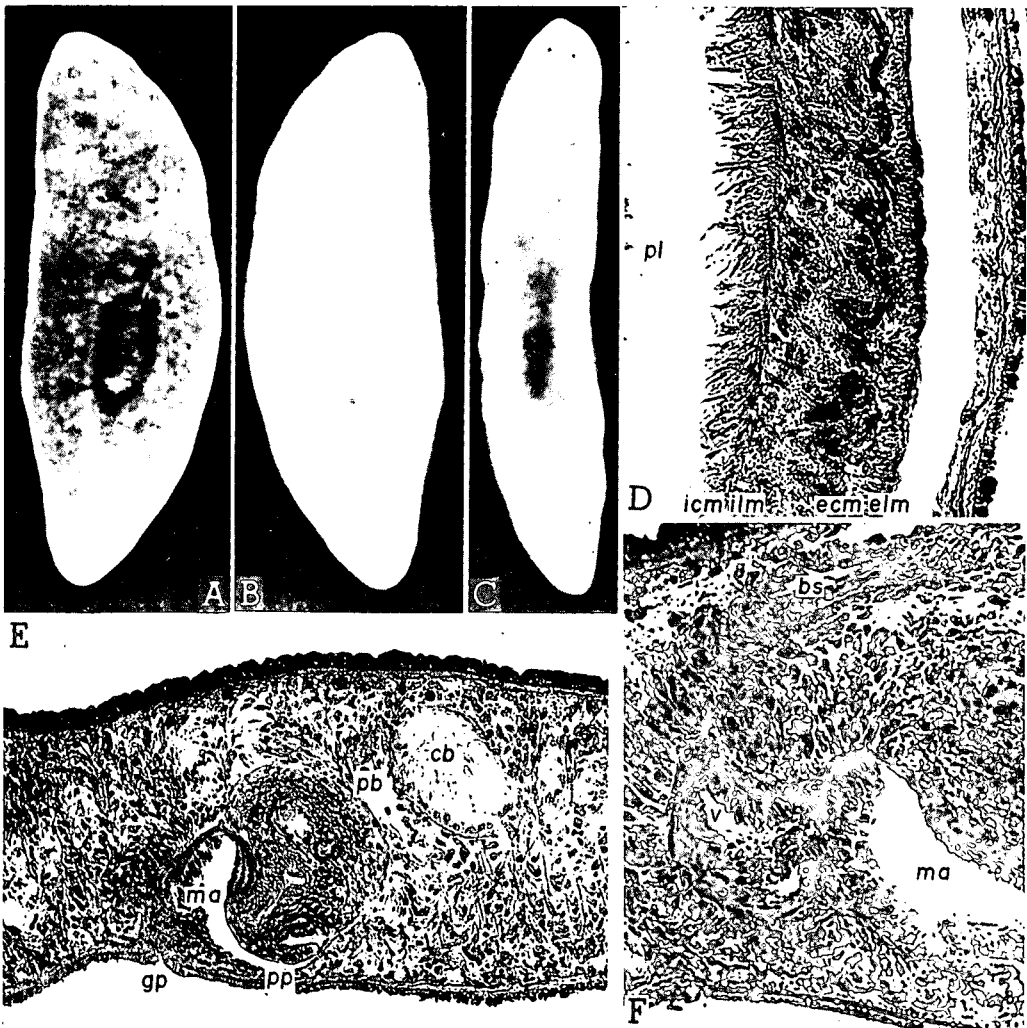


Fig. 5. *Dugesia nannophallus* from Sri Lanka (Specimen Lot No. 1106 group). A: a preserved sexually mature specimen (No. 1106 g). B: ventral view of the Specimen A. C: a preserved sexually immature specimen (No. 1106 group). D: photomicrograph of the sagittal section of the part of the pharynx (No. 1106 a). E: photomicrograph of the mid-sagittal section of the copulatory apparatus (No. 1106 g). F: enlarged photomicrograph of the posterior part of the copulatory apparatus (No. 1106 g). **bs**: bursa stalk; **cb**: copulatory bursa; **ecm**: external circular muscles of the pharynx; **elm**: external longitudinal muscles of the pharynx; **gp**: genital pore; **icm**: internal circular muscles of the pharynx; **ilm**: internal longitudinal muscles of the pharynx; **ma**: male antrum; **pb**: penis bulb; **pl**: pharynx lumen; **pp**: penis papilla; **v**: vagina.

Dr. H. H. COSTA of the University of Sri Lanka (formerly University of Ceylon) Kindly sent the senior author the triclad material from Ceylon.

Material and Locality: KAWAKATSU's Specimen Lot No. 1106 group. A small stream at Peradeniya near Kandy, Central Province, Sri Lanka. Altitude, about 300 m. March 20, 1972. About 30 specimens fixed in Bouin's fluid, 6 to 8 mm long and 1 mm broad, were examined. Only one specimen was observed in a sexually mature state. Coll. Dr. H. H. COSTA.

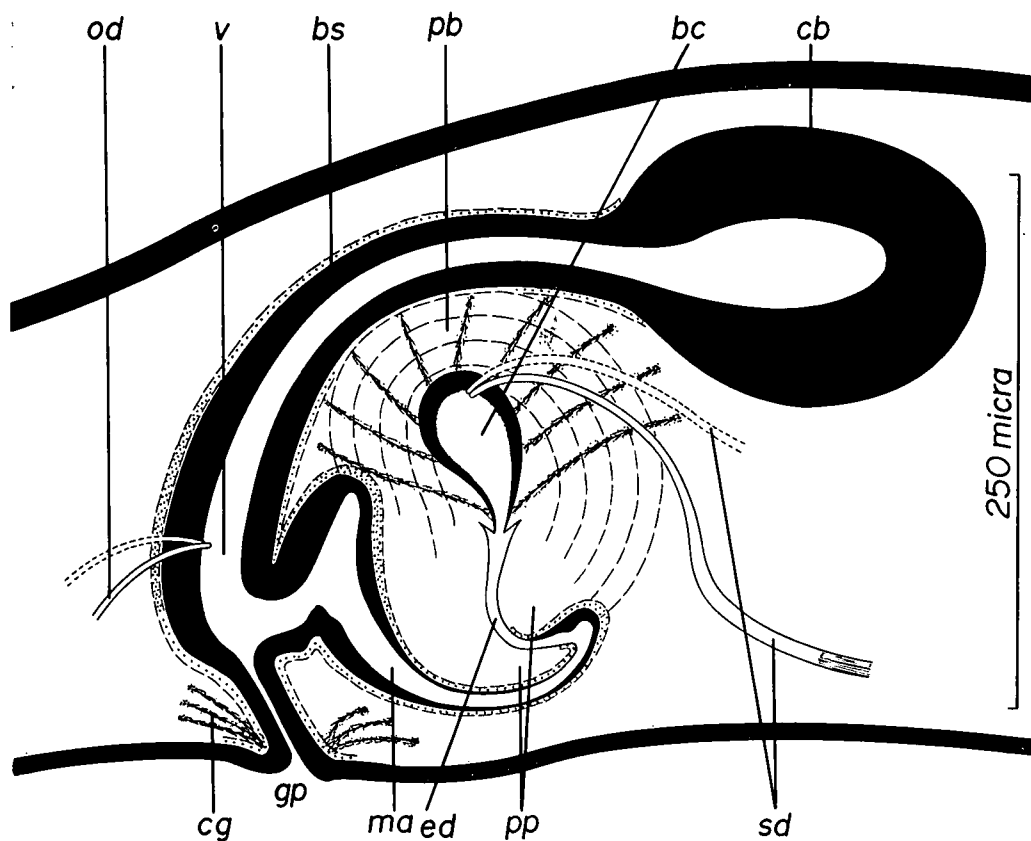


Fig. 6. Diagram showing the sagittal view of the copulatory apparatus of *Dugesia nannophallus* (No. 1106 g). Abbreviations, see Fig. 2.

External Characters: The appearance of the preserved specimens is shown in Figure 5 (A-C). The preserved sexually mature specimen attains 8 mm in body length and 1.2 mm width. Sexually immature specimens are usually smaller in size than the sexual specimen. The head has a broad triangular form with short, bluntly pointed auricles.

The color of the dorsal side is light brown with numerous, dark pigment patterns. The ventral side is a lighter hue.

The two eyes, each surrounded by a clear space, are situated on the usual position of the head; the distance between them is about one-third of the head at the level of eyes. A pair of the non-pigmented auricular sense organs is small but conspicuous.

The pharynx is inserted somewhat behind the middle of the body and measures in length about one-sixth of the body length. The genital pore opens at about the anterior one-third level of the postpharyngeal region.

Internal Characters: The anterior intestinal trunk bears about 18-20 branches on each side. Each posterior trunk has 12 to 15 short lateral branches. The external muscle layers of the pharynx consist of outer longitudinal and inner circular fibres (Fig. 5 D).

The genital anatomy of *Dugesia nannophallus* has been described by BALL (1970). Numerous, small, dorsal testes, ovaries and yolk glands were observed in the slides examined (No. 1106 g). Photomicrograph of the copulatory apparatus is shown in Figure 5 (E and F). The sagittal view of the

copulatory apparatus is also shown in Figure 6.

The copulatory apparatus of the specimen examined may show the penis papilla preserved in a contracted condition. The penis bulb and the copulatory bursa are apparently preserved in a normal condition (Figs. 5 E, 6).

Regarding the genital anatomy of this species there are some minor differences between the present material and Dr. BALL's. In the present authors' slides examined, the copulatory bursa is a middle-sized organ and is an oval in shape. The bursa stalk is a long and slender duct. Its anterior and middle parts have a thin muscular coat consisting of an inner circular and an outer longitudinal one. The terminal part of the bursal canal is slightly expanded and lined by a tall, thicker epithelium of a nucleate type than that of the middle and anterior parts of the canal (i. e., vagina). The muscle fibres of the vagina consist of three layers, an inner thin layer of longitudinal, a slightly wide layer of circular and an outer thin layer of longitudinal.

The main characters of the copulatory apparatus are as follows: penis bulb large, spherical in shape and muscular with a moderately wide pestle-shaped bulbar cavity into which sperm ducts enter separately; highly asymmetrical penis papilla moderately large and conical from with large diaphragm in the ejaculatory duct which opens on the under side of the penis papilla near its tip (the dorsal lip of the papilla is extraordinarily large compared with the ventral one); without a valve surrounding the papilla at the basal part; copulatory bursa moderate, with a narrow bursal canal which opens into the narrow common antrum; ovovitelline ducts open separately into the terminal part of the bursa stalk.

Slides: Ten sets of serial sections (Specimen No. 1106 a-j) and several whole mounts are preserved in KAWAKATSU's laboratory of Fuji Women's College, Sapporo. A number of preserved specimens in alcohol are also retained by the senior author.

Remarks: There has been the discussion by BALL (1970) about the taxonomic affinities of *Dugesia nannophallus*. Anatomically, the species approaches most closely to *Dugesia burmaensis* (KUBURAKI, 1918) from Burma, *Dugesia andamanensis* (KABURAKI, 1925) from the Andaman Islands, and *Dugesia indica* KAWAKATSU, 1969, from Middle India.

Recently, a new *Dugesia* species from the vicinity of Madurai, Tamil Nadu, South India, has been studied by the senior author (KAWAKATSU & BASLL, In press; this paper will be published in March, 1975; see also KAWAKATSU & BASIL 1971). The distance between Madurai and the localities of *Dugesia nannophallus* in Ceylon may attain about 400 kilometers. Both species are quite different from each other in the details of their penial anatomy.

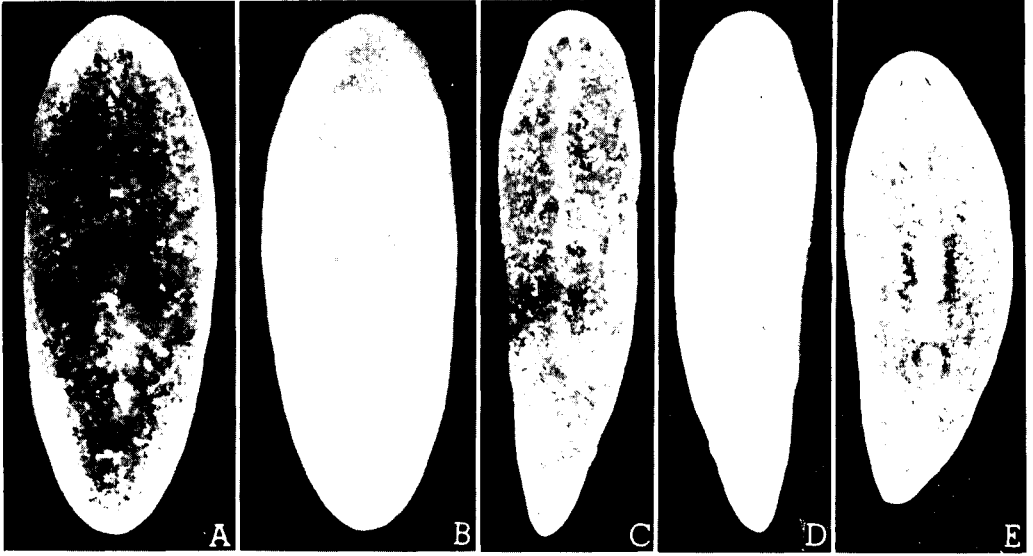
***Dugesia lindbergi* DE BEAUCHAMP, 1959**

Figs. 7 (A-J), 8 (A-H) and 9 (A-C)

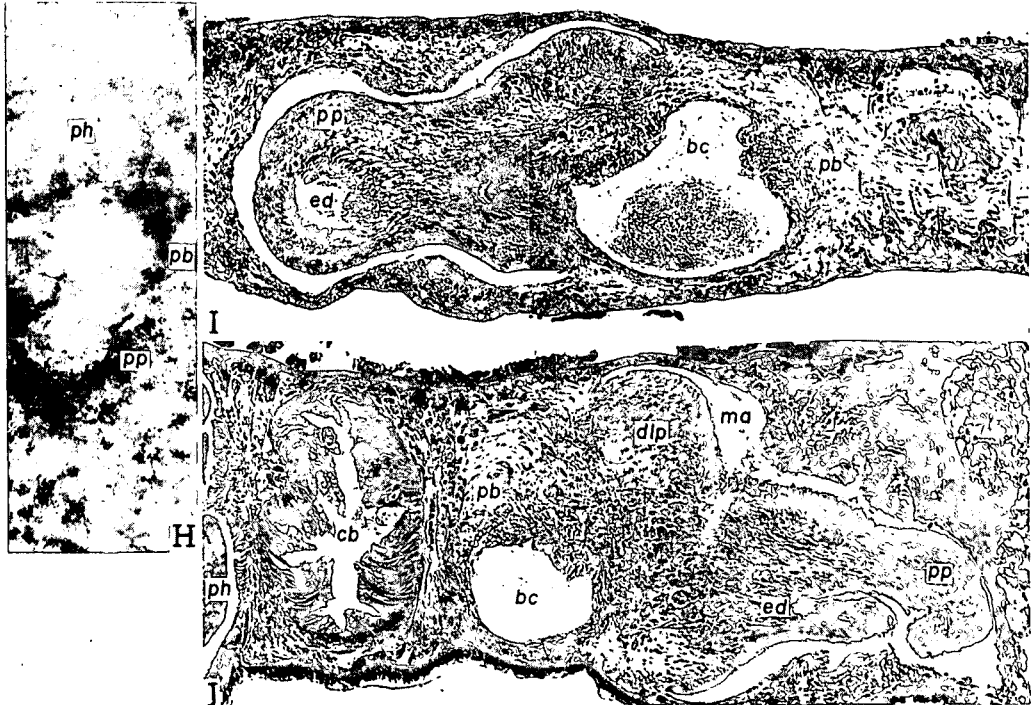
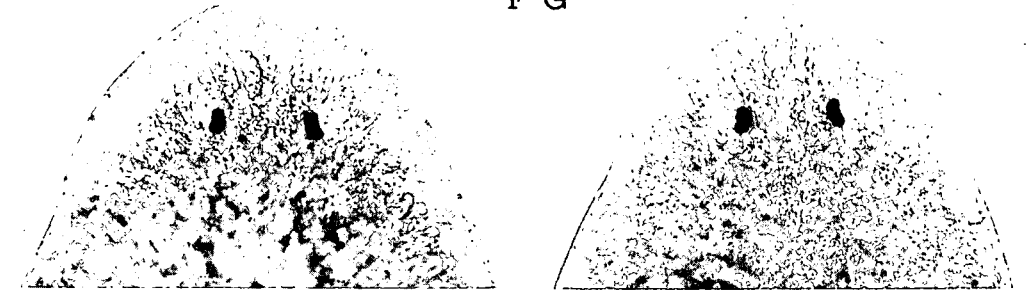
Dugesia lindbergi DE BEAUCHAMP, 1959. Kungl. Fysiograf. Sällsk. I. Lund Förhandl., 29 (3): 34-36, Fig. 5. Original description (Afghanistan).

Dugesia lindbergi DE BEAUCHAMP, 1959, in KAWAKATSU 1973 b. Bull. Fuji Women's College, No. 11, Ser. II: 84-88, Figs. 2 (B), 3 (B and C), 7, and 8 (A and B). Redescription of the material from Pakistan with taxonomic remarks. Other literature, see KAWAKATSU (1973 b).

Miss Kamlesh VASHISHT, who studying the planarian cytology in the laboratory of Dr. G. P. SHARMA, Panjab University, India, requested the identification of the material of Indian freshwater planarians by the senior author. The samples, which were fixed in Bouin's fluid, consist of five vials. On examination, the animals from one locality were identified as *Dugesia lindbergi* DE BEAUCHAMP, 1959. The animals from the other two localities proved to be in a sexually immature state (see next



F G



paragraph). She kindly sent to the senior author a number of brief sketches of the living animals and pertinent collection data.

Material and Locality: KAWAKATSU's Specimen Lot No. 1255 group. A small mountain stream called the Pinjore Brook near Chandigarh (north-western side of the Great Himalayan Range), Panjab district, North India. Altitude, about 1000 m. February to March, 1974. About 50 specimens fixed in Bouin's fluid, 10 to 12 mm long and 1 to 2 mm broad, were examined. About half of them were observed in a sexually mature state. Coll. Miss K. VASHISHT.

External Characters: The appearance of the preserved specimens is shown in Figure 7 (A-G). According to the observations made by the collector (in litt.), the head has a rather pointed subtriangular form with blunt auricles. The general color of the dorsal side is light brown to dark brown. On examination of the preserved specimens, numerous, blackish brown pigment patterns are observed. The ventral side shows a light coloration with numerous, small, light brown pigments. Indistinct white stipples or sensory spots were found at the anterior margin of the head (Fig. 7 F and G). *1

The two eyes, each surrounded by a pigment-free ocular area, are situated on the usual dorsal position; the distance between them is about one-third of the head at the level of the eyes. The non-pigmented auricular sense organ is conspicuous.

The pharynx is inserted at about the middle of the body. The genital pore opens at about the middle of the postpharyngeal region.

Internal Characters: The genital anatomy of *Dugesia lindbergi* has already been studied by DE BEAUCHAMP (1959, 1961) and KAWAKATSU (1973 b). The authors wish to add here only some additional observations concerning the local variation of the genital anatomy of the animals from the Pinjore Brook locality in North India.

Photomicrographs of the parts of the copulatory apparatus are shown in Figures 7 (H-J) and 8 (A-H). Sagittal view of the copulatory apparatus of three specimens from the Pinjore Brook locality are also shown in Figure 9 (A, B and C). In these diagrammatic figures, two of them (A and C) show the penis in a contracted state; the remaining one (B), the penis in an elongated state.

The dorsal testes, ovaries and yolk glands were observed in the slides of the fully mature specimens. The following characters in the anatomy of the copulatory apparatus were seen in the specimens from the Pinjore Brook locality. The large penis bulb has a semi-ovoidal shape and contains a very wide bulbar cavity into which two sperm ducts open separately. The lining glandular epithelium of the bulbar cavity is usually thicker at the roof of the cavity than at the floor. In the Pakistan specimens (cf. KAWAKATSU 1973 b, p. 86, Fig. 7), the bulbar cavity is somewhat narrower than that of the North Indian specimens. Its lining glandular epithelium is much thicker in the specimens from the populations of Afganistan (cf. DE BEAUCHAMP 1959, p. 35, Fig. 5 C) and Pakistan (op. cit.) than in the North Indian specimens.

*1. The animals from Pakistan have distinct white stipples (10-20 in number) (cf. KAWAKATSU 1973 b, p. 83, Fig. 3 B and C).

Fig. 7. *Dugesia lindbergi* from North India (Specimen Lot No. 1255 group). A-E: three preserved sexually mature specimens (No. 1255 group). B: ventral view of the Specimen A. D: ventral view of the Specimen C. F and G: head of two preserved specimens (whole mounts; No. 1255 group). H: general view of the copulatory apparatus (whole mount; No. 1255 group). I and J: photomicrographs of the near mid-sagittal sections of the copulatory apparatus. I: No. 1255 r. J: No. 1255 t. bc: bulbar cavity; cb: copulatory bursa; dlp: dorsal lip of the penis; ed: ejaculatory duct; ma: male antrum; pb: penis bulb; ph: pharynx; pp: penis papilla.

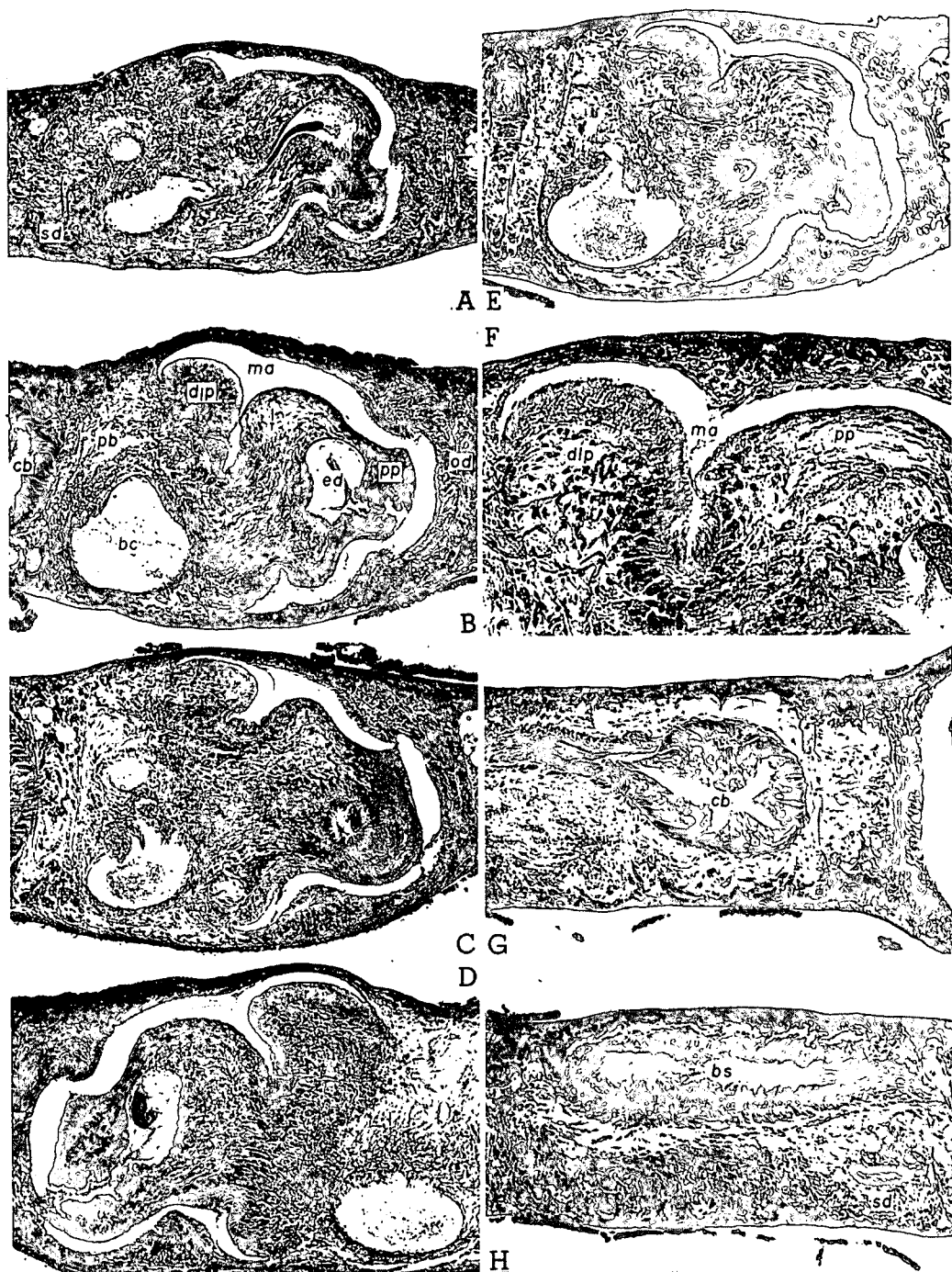


Fig. 8. *Dugesia lindbergi* from North India. Photomicrographs showing the parts of the copulatory apparatus. A-E: mid-sagittal sections of the copulatory apparatus. A: No. 1255 b. B: No. 1255 i. C: No. 1255 n. D: No. 1255 o. E: No. 1255 u. F: enlarged photomicrograph of the anterodorsal part of the penis No. 1255 u). G: copulatory bursa (No. 1255 r). H: a part of the bursa stalk (No. 1255 r). **bc**: bulbar cavity; **bs**: bursa stalk; **cb**: copulatory bursa; **dip**: dorsal lip of the penis; **ed**: ejaculatory duct; **ma**: male antrum; **od**: ovovitelline duct; **pb**: penis bulb; **pp**: penis papilla; **sd**: sperm duct.

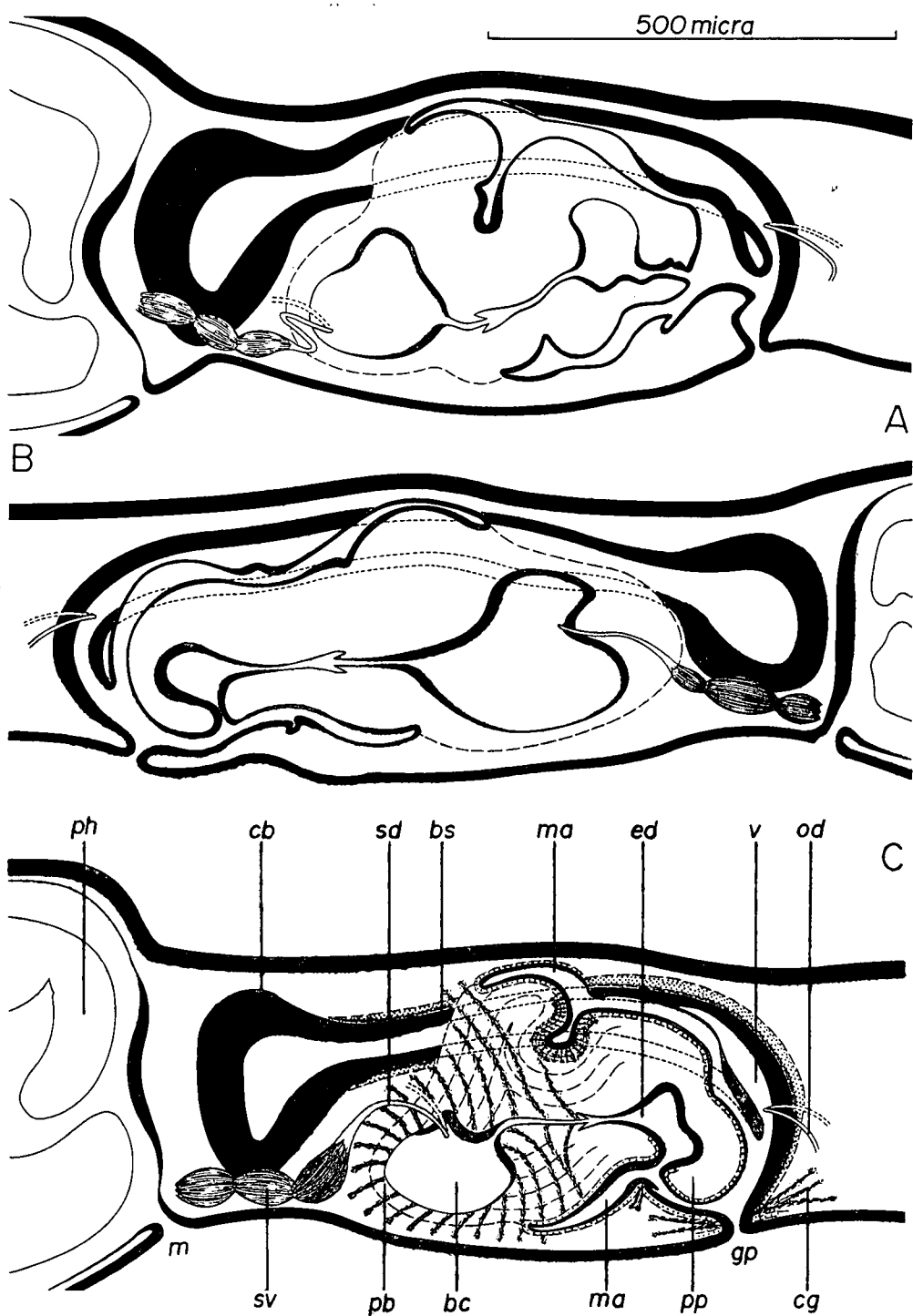


Fig. 9. Diagrams showing the sagittal views of the copulatory apparatus of *Dugesia lindbergi*. A: No. 1255 i. B: No. 1255 r. C: No. 1255 u. Abbreviations, see Fig. 2.

The asymmetrical penis papilla is very large in the North Indian specimens. The bulbar cavity and the ejaculatory duct are separated by a well-developed diaphragm. The ejaculatory duct usually forms a rather wide lumen at its middle part and opens at the ventral side of the penis papilla near its tip (Fig. 8 A, B and C). In the specimens from the populations of Afghanistan and Pakistan, the ejaculatory duct represents as a narrow tubular lumen. The valve at the base of the dorsal lip of the penis papilla is well-developed in the North Indian specimens. A glandular cavity or a hollow adenodactyl-like structure of the dorsal lip of the penis papilla (i. e., a narrow space between the under surface of the dorsal valve and the upper surface of the dorsal lip of the penis papilla) is also well-developed (Figs. 7 J, 8 A-F, 9 A-C). The above-mentioned valve of the penis papilla is less-developed in the specimens from the populations of Afghanistan and Pakistan.

In the North Indian specimens, a glandular fold or a slit is differentiated on the floor of the male genital antrum at the region near the genital pore (Figs. 7 J, 8 A and D, 9 A-C). The secretion of the gland ducts contains eosinophilous granules. The same structure is found in the animals from several populations of *Dugesia indonesiana* KAWAKATSU, 1973 (cf. KAWAKATSU 1973 a, pp. 94-95, Fig. 3 B and C).

The copulatory bursa of the North Indian specimens is a large, spherical shaped organ (Figs. 7 J, 8 G). The glandular epithelium of the bursal canal has insunk nuclei. In the specimens from Pakistan, the entire course of the bursal canal has a nucleate epithelium (cf. KAWAKATSU 1973 b, p. 88). The muscle fibres of the bursa stalk consist of three layers, i. e., an inner thin layer of longitudinal, a wide layer of circular and an outer thin layer of longitudinal (Fig. 8 H). This character is also found in the specimen from Afghanistan, Pakistan and North India.

Slides: Twenty-six sets of serial sections (Specimen No. 1255 a-z) and several whole mounts are preserved in KAWAKATSU's laboratory of Fuji Women's College, Sapporo. A number of preserved specimens in alcohol are also retained by the senior author.

Remarks: The affinities of *Dugesia lindbergi* were discussed in a previous paper (cf. KAWAKATSU 1973 b). The range of the geographical distribution of this polymorphic species has been made rather clear. The species may be common in the upper part of the Indus River (i. e., the north-eastern part of Afghanistan, the northern part of Pakistan, and North India). It is highly probable that the species may also occur in Kashmir in North India. Although BALL (1974, p. 378) reported the occurrence of a species from Malaya which he assigned to *Dugesia lindbergi*, this record is uncertain.

***Dugesia* spp. (species of Panjab)**

Fig. 10 (A-L)

Material and Locality: KAWAKATSU's Specimen Lot No. 1271 group. A hilly stream at Dharmpur near Chandigarh, Panjab district, North India. Altitude, about 1475 m. July, 1974. Nine specimens fixed in Bouin's fluid, 6-8 mm long and 1 mm broad, were examined. None of the animals are of sexually mature state. Water temperature, 6-7°C. Coll. Miss H. VASHISHT. KAWAKATSU's Specimen Lot No. 1272 group. A hilly stream at Solan near Chandigarh, Panjab district, North India. Altitude, about 1525 m. July, 1974. About 25 specimens fixed in Bouin's fluid, 5 to 13 mm long and 0.5 to 1.5 mm broad, were examined. None of the animals are of sexually mature state except for one non-fully mature specimen (No. 1272 i). Water temperature, 6-7°C. Coll. Miss H. VASHISHT.

External Characters: The appearance of the preserved specimens is shown in Figure 10 (A-L). It is very similar to that of the proceeding species *Dugesia lindbergi* from the Pinjore Brook locality. In the material examined several specimens exhibited freshly regenerated anterior and posterior ends, indicating that asexual reproduction by fission was taking place.

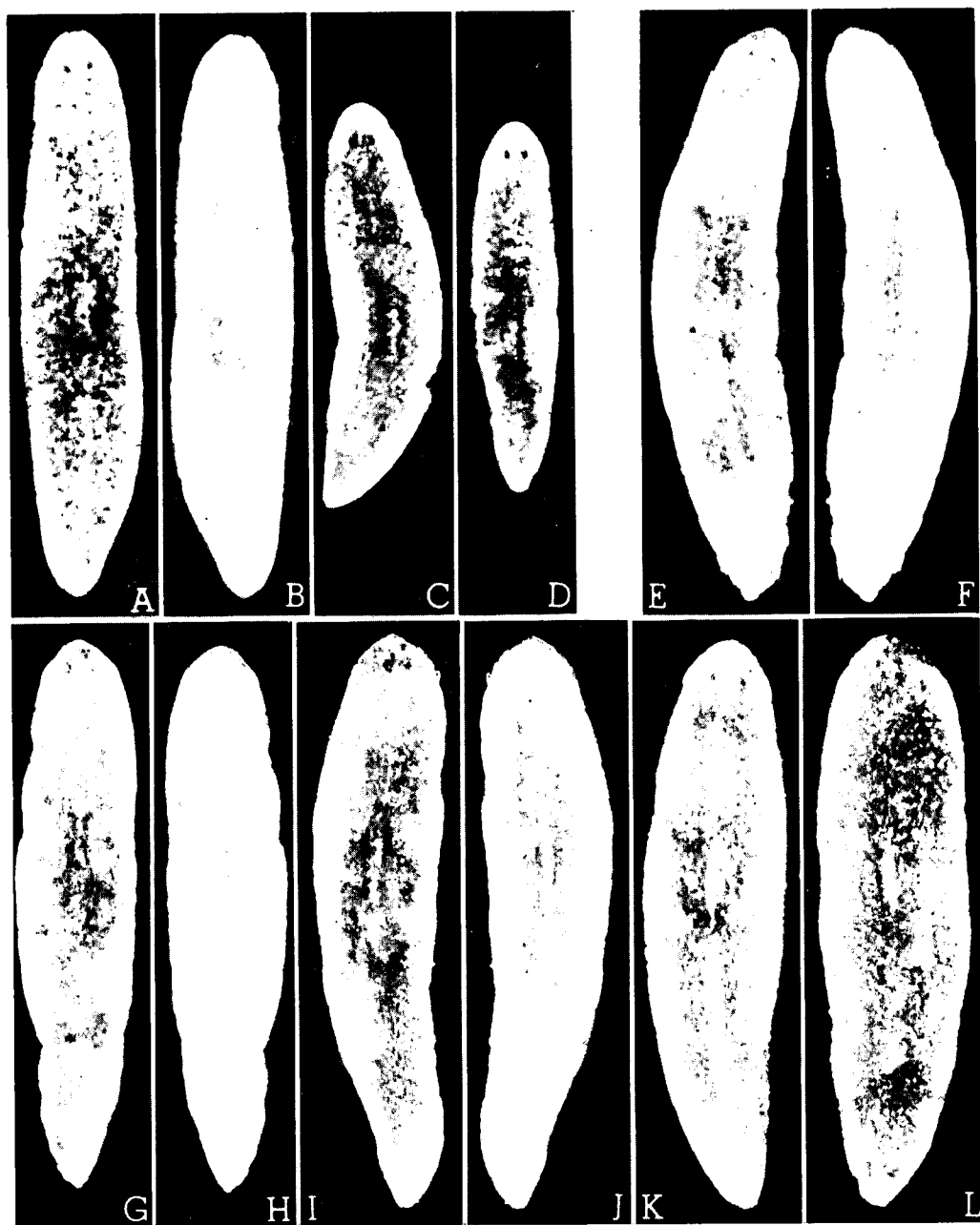


Fig. 10. *Dugesia* spp. (species of Panjab) from North India (Specimen Nos. 1271 and 1272 groups). A-D : three preserved sexually immature specimens from the Dharmpur locality (No. 1271 group). B : ventral view of the Specimen A. E-L : five preserved sexually immature specimens from the Solan locality (No. 1272 group). F : ventral view of the Specimen E. H : ventral view of the Specimen G. J : ventral view of the Specimen I.

Internal Characters: The external muscle layers of the pharynx consist of outer longitudinal and inner circular fibres. In the slides of the Specimen No. 1272 i, it was seen that the differentiation of partially developed penis papilla protruded into the genital antrum. The genital pore was also seen.

Slides: Sixteen sets of serial sections (Specimen Nos. 1271 a-g, 1272 a-i and several whole mounts are preserved in KAWAKATSU's laboratory of Fuji Women's College, Sapporo. A number of preserved specimens in alcohol are also retained by the senior author.

Remarks: It is highly probable that *Dugesia* spp. (species of Panjab) recorded here may be identical with *Dugesia lindbergi*.

? *Dugesia* sp. (species of Transvaal)

Fig. 11 (A and B)

Dr. F. R. SCHOEMAN of National Institute for Water Research, Pretoria, South Africa, kindly sent to the senior author the triclad material from South Africa.

Material and Locality: KAWAKATSU's Specimen Lot No. 1219 group. A small stream called the "Klein Jukskei" is situated between Johannesburg and Pretoria, Transvaal, South Africa. Altitude, about 1800 m. July 20, 1973. Twelve specimens fixed and preserved in 70 % ethyl alcohol, 5-8 mm long and 0.5-1 mm broad, were examined. None of the animals are of sexually mature state. Without data of water temperature; pH 8.1. Coll. Dr. F. R. SCHOEMAN.



Fig. 11. *Dugesia* sp. (species of Transvaal) from South Africa (Specimen Lot No. 1219 group). A and B: two sexually immature specimens (No. 1219 group).

External Characters: The appearance of the preserved specimens is shown in Figure 11 (A and B). The largest sexually immature specimen in the preserved condition attains 8 mm in body length and 1 mm width. The head has a broad subtriangular form with short, bluntly pointed auricles. The anterior end is rather rounded.

The color of the dorsal side is uniformly dark brown with numerous, indistinct blackish brown pigments. The ventral side is a lighter hue.

The two eyes are situated on the dorsal side of the head. Their distance from each other amounts to somewhat more than one-third the width of the head at the level of the eyes. The pigment-free ocular areas are conspicuous.

The mouth is situated at rather posterior level of the body. In many specimens examined, the pharynx was protruded from the mouth. This may be due to the effect of fixative.

Slides: Several whole mounts and remaining specimens in alcohol are preserved in KAWAKATSU's laboratory of Fuji Women's College, Sapporo.

Remarks: Judging from the external appearance of the non-sexual specimens, it is highly probable that ?*Dugesia* sp. (species of Transvaal) may be identical with *Dugesia neumanni* (NEPPI, 1904) (cf. KAWAKATSU 1972 d).

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Addendum.

The senior author wishes here to correct his footnote 2 in a previous paper (KAWAKATSU 1973 b, p. 92) that the Teheran population of "*Euplanaria cretica* MEIXNER" (in DE BEAUCHAMP 1936) is *Dugesia iranica* (LIVANOW, 1951). Cf. LIVANOW, N. A., 1951. Trudy Murgabskoi Gidrobiologicheskoi Stantsii, 1: 103-114.

Redescription of *Dugesia cretica* (MEIXNER, 1928) from Rumania is found in the following paper: NĂSTĂSESCU, M., 1972. Studii și Cercetări de Biologie, Ser. Zool., 24 (6): 513-519.

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